

SECTION I.—AEROLOGY.

SOLAR AND SKY RADIATION MEASURED AT WASHINGTON, D. C., DURING OCTOBER, 1915.

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[Dated: Washington, D. C., November 16, 1915.]

In Table 1 are summarized the measurements of the intensity of direct solar radiation made by the Weather Bureau at the American University,¹ Washington, D. C., during October, 1915. The means for the month are slightly lower than the 5-year means published in the Bulletin of the Mount Weather Observatory, 1912, 5:182, Table 3.

Skylight polarization, measured at solar distance 90° and in his vertical, with the sun at zenith distance 60°, averaged 64 per cent, with a maximum of 70 per cent on the 23d. This latter is 6 per cent higher than the average maximum polarization for October published in the Bulletin of the Mount Weather Observatory, 1910, 3:114, Table 16, and 1 per cent higher than any polarization measurement previously obtained at Washington in October.

TABLE 1.—Solar radiation intensities at Washington, D. C., during October, 1915.

[Gram-calories per minute per square centimeter of normal surface.]

Date.	Sun's zenith distance.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°	80.7°
	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
A. M.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.
October 3.....						0.79	0.72				
4.....	1.02	0.88	0.75								
8.....	1.07	0.92	0.81								
9.....	1.30	1.20	1.12	1.05	0.97	0.88	0.82	0.77	0.72	0.66	
10.....	1.32	1.22	1.14	1.06	0.98	0.93	0.87	0.83	0.76	0.72	
11.....	1.31	1.09	1.00	0.97	0.94	0.87	0.81	0.76	0.70	0.65	
12.....	1.33	1.25	1.18	1.11	1.04	0.98	0.91	0.86	0.82	0.79	
23.....	1.38	1.08	0.93	0.74							
25.....	1.15		0.94	0.86	0.75						
26.....	1.14	1.01	0.89	0.79	0.73	0.68	0.63				
28.....	1.09	0.97	0.90		0.70						
30.....				0.84	0.76						
31.....				1.05	1.01	0.98	0.94	0.89	0.84	0.79	
Means.....	1.21	1.07	0.97	0.94	0.87	0.86	0.83	0.82	0.77	0.72	
P. M.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.
October 4.....	1.22	1.07	0.93	0.84	0.75		0.57				
8.....	1.12	1.23	1.16	1.04	0.91	0.81	0.72				
11.....	1.31	1.17	1.08	1.01		0.87	0.80				
12.....	1.31	1.22	1.13	1.06	0.99	0.92	0.86	0.80			
21.....	1.25	1.11	1.04	0.93	0.84	0.76	0.69	0.63			
23.....	1.26	1.16	1.06	0.98	0.91	0.84	0.78	0.73	0.70		
25.....	1.00	0.89		0.67	0.61	0.57	0.52	0.48			
27.....	1.23	1.15	1.05	0.96	0.88	0.82	0.77	0.72	0.69	0.64	
28.....	0.93	0.80	0.72	0.65	0.61	0.57	0.53	0.49	0.45		
30.....		1.14	0.91	0.85	0.83	0.81	0.79	0.76	0.73		
Means.....	1.24	1.13	1.02	0.94	0.83	0.79	0.72	0.68	0.62	0.60	

In Table 2, column 2 gives the daily totals of solar and sky radiation received on a horizontal surface at the American University during October, 1915. The measurements were made with a Callendar recording pyrheliometer, as described in the REVIEW for March, 1915, 43:100. Table 2, column 3, gives the daily departures from the normals published in the same number of the REVIEW, page 110, Table 4.

The "Percentage of possible sunshine" and the "Average cloudiness," given in columns 5 and 6, Table 2, have been taken from the records of the observatory of the central office of the Weather Bureau. The monthly mean percentage of possible sunshine is 63, or practically the same as the normal for October.

The above data indicate the usual number of hours of sunshine during October, but radiation intensities slightly below the average for the month. The third decade was the only one showing radiation in excess of the normal.

TABLE 2.—Daily totals and departures of solar and sky radiation at Washington, D. C., during October, 1915.

[Gram-calories per square centimeter of horizontal surface.]

Day of month.	Daily totals.	Departure from normal.	Excess or deficiency since first of month.	Percentage of possible sunshine.	Average cloudiness.
	Gr.-cal.	Gr.-cal.	Gr.-cal.	Per cent.	0-10.
October 1.....	61	-275	-275	1	10
2.....	196	-138	-413	17	8
3.....	381	50	-363	100	0
4.....	411	83	-280	100	1
5.....	136	-180	-470	9	9
6.....	199	-124	-604	28	8
7.....	64	-250	-850	0	10
8.....	390	72	-778	93	3
9.....	357	42	-736	75	3
10.....	438	126	-610	100	0
11.....	423	123	-487	100	0
12.....	429	122	-365	100	0
13.....	322	18	-347	54	6
14.....	189	-113	-460	22	9
15.....	294	5	-465	74	6
16.....	34	-262	-737	0	10
17.....	57	-236	-963	0	10
18.....	92	-198	-1,161	0	10
19.....	244	-43	-1,204	44	8
20.....	137	-147	-1,351	4	10
Decade departure.....			-741		
October 21.....	289	8	-1,343	75	3
22.....	339	61	-1,282	97	2
23.....	366	91	-1,191	100	0
24.....	390	118	-1,073	100	0
25.....	335	66	-1,007	100	0
26.....	300	34	-973	92	3
27.....	330	67	-906	88	3
28.....	297	37	-839	109	0
29.....	303	46	-823	103	5
30.....	338	83	-740	100	0
31.....	309	57	-683	100	1
Decade departure.....			668		
Total excess or deficiency since first of year.....			-1,704		

EFFECTS OF HURRICANES ON THE UPPER AIR CURRENTS.

By Prof. W. H. PICKERING.

[Dated: Mandeville, Jamaica, Nov. 13, 1915.]

It is well known to astronomers that if we point a telescope on a bright star, remove the eyepiece, and place the eye near the focus, we shall perceive a bright disk crossed by dark fluctuating dots or lines due to air currents in our upper atmosphere. The same result is obtained if we draw out the eyepiece a few millimeters beyond the focus. In the latter case if we determine the number of millimeters, we can readily compute the altitude of the current whose motion we are observing. The dark lines travel longitudinally, and the diameter of the objective divided by their number gives us the linear distance between them.

It has been the writer's fortune, good or bad, to be on the island of Jamaica during the passage of four hurricanes in its vicinity. The atmospheric definition, which is of fundamental importance in all astronomical observations, is exceptionally good on this island, as it probably is in most tropical countries as compared with what is found in northern latitudes. In each case, however, a few days before the passage of the hurricane the definition, or "seeing" as it is usually called, dropped to a very marked degree, indeed it became as bad as it usually is in the north. Such bad "seeing" is never experienced here unless a hurricane is in the vicinity. To express the fact numerically, the "seeing" usually fluctuates here

¹ For a description of exposures of instruments and details of methods of observation see this REVIEW, December, 1914, 42:648.

from 8 to 12, the latter being perfect. On rare occasions it drops to 6, which is about the best we have in Cambridge, Mass. At the approach of a hurricane the "seeing" drops to 4 and sometimes to 3.

This fact was first noted in August, 1899, at the time of the passage of a severe hurricane to the north of Haiti. The center was at a distance of 450 miles and did not reach Jamaica (Annals, Harvard Observatory, v. 61, p. 21). The next observation was from our present station in Mandeville in 1912. On the evening of November 9 the "seeing" had been rather poor, 7, but at midnight it suddenly dropped to 3. After that we had continuously cloudy nights and no observations were secured for two weeks. The disturbance was not announced by the Weather Bureau until November 12, but on the 9th the center was probably located about 500 miles to the south of us. On November 15, 16, and 17 we had 19.70 inches of rain, but the center did not pass us until the 18th. It came within 25 miles of us, and the maximum velocity of the wind was estimated at 55 miles.

The third hurricane observed occurred in August of the present year. On the evening of the 10th the seeing in the zenith was noted as 11. The next afternoon the highest maximum temperature in three years was recorded here, 88.7°F. and we were informed that the Weather Bureau indicated a disturbance south of Porto Rico, some 800 miles to the east of us. Since the hurricane center is always small, the chance that it will strike us is not very great. We do not consider its mere proximity as a very dangerous phenomenon, either to ourselves personally or to our instruments, but it is certainly a nuisance. It not only always damages our bananas and shrubs, but it interferes for a number of days with our observations. It was therefore with some considerable interest that we turned our telescope to the zenith that evening to look at the indications. There was no mistaking them, the seeing had dropped to 4, and the image was constantly fluctuating in both size and shape. Yet to the naked eye the stars appeared as steady as usual, no twinkling being visible at a greater altitude than 30°. The center passed 50 miles to the north of us at 3 a. m. of August 13. The maximum wind velocity was estimated at 40 miles, but it may have been rather higher in the nighttime. The total rainfall on the 12th, 13th, and 14th was 15.85 inches.

Our fourth hurricane came in September. On the night of the 21st the seeing on the moon was recorded as 8. Doubtless in the zenith it would have been higher, perhaps 10. The next night at 8 o'clock it was reduced to 5, and at 4 o'clock the following morning to 4. There was no doubt but that there was trouble again to the east of us. The distance of the center at this time was 750 miles. We focused on the air currents, and found them coming from the east 20° south, rather slowly, the lines occasionally breaking into dots. They came pretty nearly direct from the storm center. The distance between the lines was 1.5 to 2 inches. It was a very dry night, with the stars twinkling up to an altitude of 50°. The next afternoon, September 23, we received a Government report of a disturbance to the eastward. In the evening the seeing was the same, 4, but the bands now moved more swiftly and were farther apart, about 3 inches. Their direction was the same. The current therefore now came from slightly to the north of the center. The stars twinkled up to an altitude of 45°. There was a good deal of cloud after 9 p. m. September 24 was a rainy evening, but we got a few glimpses of the stars between the hurrying clouds. The direction of the bands had now shifted to east 6° south, which was parallel to the motion of the center, and their velocity was so high that we could not tell whether they were traveling

east or west. Their breadth had increased to 5 inches. The wind came in gusts from the east, estimated at 8 miles. The center was now some 200 miles to the south-east of us.

Our telescope is of 11 inches aperture, furnished with a diagonal eyepiece for zenith observations. When the eyepiece was pulled out 5 millimeters beyond the focus, the air currents were easily seen, and even at 2 millimeters they were visible. This latter would correspond to an altitude of 6 miles. The lowest altitude observed was 1.5 miles. The direction seemed to be the same at both altitudes, but observations could only be made through occasional holes in the clouds, while it was not desirable to expose the telescope to the frequent showers. Observations were therefore somewhat imperfect.

The writer has received a tracing of the path of this hurricane through the kindness of the Government meteorologist, Mr. Maxwell Hall.¹ The center passed 90 miles to the south of us early September 25. The wind was not estimated higher here than 25 miles. The total rainfall on September 25, 26, and 27 was 18.39 inches, 9.90 inches falling on the first date, which is our record for the past three years.

22° HALO WITH UPPER AND LOWER TANGENT ARCS.

By C. G. ANDRUS, Assistant Observer.

[Dated: Weather Bureau, Richmond, Va., Oct. 26, 1915.]

The cirro-stratus clouds which covered the sky at noon October 26, 1915, at Richmond, Va., were the occasion for a complete solar halo in combination with the upper and lower tangent arcs (c and d?, fig. 1) that are sometimes observed with this halo. The radius of the halo (as measured with the device described in this REVIEW, May, 1915, p. 214) was 21° 30'. The lower summit resembled a parhelion and was of a bright, whitish color, but of little lateral extent. The upper summit was longer, of better colors, and had a flattening effect on the appearance of the halo at this point.

At 12:50 p. m. (75th mer. time) there was little change in arrangement, but the colors were more brilliant.

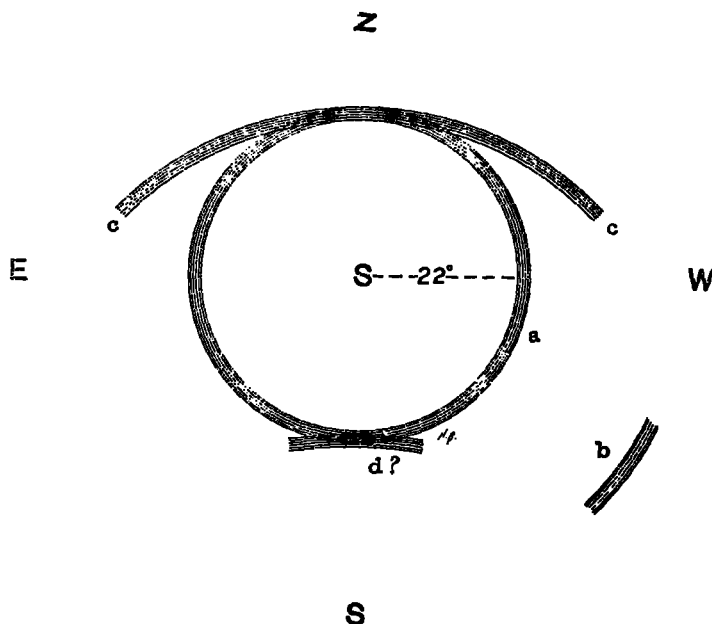


FIG. 1.—22°-halo α and tangent arcs c and d? with a fragment of the 46°-halo (?), b, seen at Richmond, Va., 1915, 26 Oct., 1:50 p. m. (75th M. S. T.).

At 1:50 p. m. the halo had faded noticeably while the tangent arcs had brightened and lengthened, especially

¹ Details of the experience of Jamaica during these hurricanes of August and September, 1915, will be found in the Jamaica Weather Report, Nos. 445, 446, and 447.